

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
20 January 2005 (20.01.2005)

PCT

(10) International Publication Number
WO 2005/006361 A3

(51) International Patent Classification⁷: **H01L 23/373**

(21) International Application Number:
PCT/US2004/018164

(22) International Filing Date: 3 June 2004 (03.06.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/607,738 26 June 2003 (26.06.2003) US

(71) Applicant: INTEL CORPORATION [US/US]; 2200
Mission College Boulevard, Santa Clara, CA 95052 (US).

(72) Inventors: HOULE, Sabina; 1347 East Redwood Lane,
Phoenix, AZ 85048 (US). DANI, Ashay; 602 West Canary
Way, Chyandler, AZ 85248 (US).

(74) Agents: STEFFEY, Charles, E. et al.; Schwegman, Lund-
berg, Woessner & Kluth P.A., P.O. Box 2938, Minneapolis,
MN 55402 (US).

(81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,

CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI,
GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE,
KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD,
MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG,
PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM,
ZW.

(84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI,
SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, ML, MR, NE, SN, TD, TG).

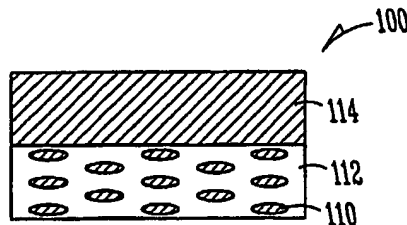
Published:

- with international search report
- before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments

(88) Date of publication of the international search report:
28 July 2005

*For two-letter codes and other abbreviations, refer to the "Guid-
ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.*

(54) Title: MULTI-LAYER POLYMER-SOLDER HYBRID THERMAL INTERFACE MATERIAL FOR INTEGRATED HEAT
SPREADER AND METHOD OF MAKING SAME



(57) Abstract: A process of making a multi-layer thermal interface material is depicted. The multi-layer thermal interface material is attached between an integrated heat spreader and a die. Processing of the multi-layer thermal interface material includes stamping or other pressure processing.

WO 2005/006361 A3

INTERNATIONAL SEARCH REPORT

Internalication No

PCT/US2004/018164

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01L23/373

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 981 085 A (NINOMIYA ET AL) 9 November 1999 (1999-11-09) column 4, line 10 - column 9, line 42; figures 2,8	1,2,5,6, 16,19-21
Y	US 4 782 893 A (THOMAS ET AL) 8 November 1988 (1988-11-08) *see Figure 2 and accompanying description*	1,2, 5-10,16, 18-24
Y	US 2002/135984 A1 (GREENWOOD ALFRED W ET AL) 26 September 2002 (2002-09-26) paragraphs [0036] - [0045], [0051], [0056]; figures 1,4 ----- -/--	1,2, 5-10,16, 18-24

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

15 February 2005

Date of mailing of the international search report

27/05/2005

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Cousins, D

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2004/018164

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>WO 02/091395 A (HONEYWELL INTERNATIONAL INC; NGUYEN, MY) 14 November 2002 (2002-11-14) the whole document -----</p>	<p>1,2, 5-10,16, 18-24</p>

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2004/018164

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1,2,5-10,16,18-24

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1,2,5-10,16,18-24

Claim 1, 2: thermal interface member having a solder preform disposed on a matrix material, insofar as the transition between the solder preform and the matrix is abrupt, the matrix being of a second heat transfer structure, with second heat transfer structures dispersed in the matrix, the second heat transfer structure being a polymer, the first heat transfer structures being of a material alternative to diamond (viz. graphite, inorganic dielectric particles, metal particles). Claims 5 - 10, 16 (insofar as the transition between the solder preform and the matrix is abrupt), 18 - 24.

2. claims: 1,3,4,16

Claim 1, thermal interface member having a solder preform disposed on a matrix material, insofar as the transition between the solder preform and the matrix is a concentration gradient. Claims 3, 4 directed to a thermal interface member having a solder preform disposed on a matrix material, with a middle heat transfer structure therebetween, the latter having a composition that is transitional between that of the matrix and that of the solder preform. Claim 16 (insofar as the transition between the solder preform and the matrix is a concentration gradient).

3. claims: 11-15

Claims 11-15: a process of forming a heat transfer composite comprising the steps of:
mixing and casting a matrix comprising a plurality of first heat transfer structures within a second heat transfer structure of a curable material; and bonding the matrix to a solder layer and forming the matrix is by co-extruding and singulating.

4. claim: 17

Claim 17: Bonding a heat transfer subsystem to a die and a heat spreader at a temperature $(T_{tim} - T_{amb})/2$.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US2004/018164

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5981085	A	09-11-1999	GB 2311414 A ,B GB 2327150 A ,B JP 10150124 A	24-09-1997 13-01-1999 02-06-1998
US 4782893	A	08-11-1988	NONE	
US 2002135984	A1	26-09-2002	EP 1354353 A1 JP 2004518294 T MX PA03006498 A TW 552690 B WO 02059965 A1	22-10-2003 17-06-2004 15-10-2003 11-09-2003 01-08-2002
WO 02091395	A	14-11-2002	US 2001038093 A1 CA 2442034 A1 CN 1552078 A EP 1386327 A1 JP 2004533705 T WO 02091395 A1 US 2004185273 A1	08-11-2001 14-11-2002 01-12-2004 04-02-2004 04-11-2004 14-11-2002 23-09-2004